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ABSTRACT

Within the context of a large computer-based instructional system (CBI), the Air Forces Advanced Instructional System, instructional needs and requirements are evaluated as determinants of computer terminal design. It is shown that traditional definitions and uses of computer managed instruction (CMI) and computer assisted instruction (CAI) must be expanded to encompass different levels of instructional requirements matched by corresponding levels of terminal hardware, terminal hardware being a major cost factor in a CBI system. A working prototype terminal using new microprocessor technology and how it was designed from one level of instructional requirements is described along with data for preliminary use of the terminal. Pilot studies of the prototype microterminal showed a high user acceptance of the device and students using the completed experimental device completed their lesson material 30% faster than a control group. While no test grade differences between users and nonusers as determined by test scores were shown, the pilot study demonstrates the viability of using microprocessor technology to solve an identified instructional need in a CBI system. References, figures, and questionnaire results are appended. (Author/JPF)

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COMPUTER-BASED INSTRUCTION: INSTRUCTIONAL DESIGN AND TERMINAL DESIGN[1]

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[1]Paper to be presented at the 1977 AERA Convention, New York.

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Computer-Based Instruction: Instructional Requirements and Terminal Design (DEF, EVA)

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Within the context of a large computer-based system (CBI), the Air Forces Advanced Instructional System, instructional needs and requirements are evaluated as determinants of computer terminal design. It is shown that traditional definitions and uses of CMI and CAI must be expanded to encompass different levels of instructional requirements matched by corresponding levels of terminal hardware, terminal hardware being a major cost factor in a CBI system. A working prototype termina using new microprocessor technology and how it was designed from one level of instructional requirements is described along with data for preliminary use of the terminal.

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Computer-Based Instruction: Instructional Design and Terminal Design[1]

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Individualized instruction which truly attempts to match student needs with instructional resources quickly produces testing and administrative requirements that soon exceed the management capabilities of a manually operated system. The U.S. Air Force realizing this situation, undertook the development of a large computer-based system encompassing both computer-managed and computer-assisted forms of instruction. The Air Force's program, called the Advanced Instructional System (AIS), has as a major goal the production of operational, cost-effective individualized instruction by taking advantage of the capabilities of computer-based instructional technology. The direction of this paper is to use the AIS program as a concrete example of the implementation of CBI and look at the concept of a hierarchy of computer terminals matched to instructional needs as a means of balancing instructional and cost considerations.

The Computer and Instruction

As with most new areas of scientific endeavor, a problem occurs with the proliferation of new terms and acronyms. Compatible activities are given different labels which make them appear different or different activities are called by the same term and thus are conceived of as being the same. Discussion of computers in education and instruction falls victim to this confusion.

[1] Paper to be presented at the 1977 AERA Convention, New York.

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Bunderson and Faust (1976) succinctly summarized this problem when they stated: "The early literature on computer-assisted, computer-aided, computer-based, and computer-managed instruction is filled with a variety of not too enlightening attempts to define and distinguish the three-letter words beginning with "C" and ending with "I" (p. 46). Suffice it to say that this paper will not attempt to add to the list of acronyms beginning with "C" and ending in "I." However, it is important to establish the context in which computer instruction is carried out for this defines the range of instructional requirements and the possibilities for the proper utilization of computer hardware.

The two major uses of computers in instruction have been labeled "CAI" (Computer-Assisted Instruction) and "CMI" (Computer-Managed Instruction). Conventionally, CAI has come to mean an intensive on-line interaction between student and computer lasting over an extended period of time while CMI has come to mean an intermittent set of interactions between computer and student used not for the transmission of instruction, but rather for the guidance of instruction. In addition, the interaction in CMI is taken to be static (submission of a form) rather than dynamic (submission through a keyboard) as it is in CAI.

The uses of computers in instruction have been a natural outgrowth of programmed instruction. Programmed instruction is characterized by a "systematic design process " (Bunderson and

Faust, 1976). The successful use of computers is also characterized by a systematic design process. Combining the systematic instructional design process of programmed instruction with the systematic control capability of computer technology provides a convenient means of properly tracking and assessing student progress and providing students with controlled informative feedback. As it has been tentatively indicated, the functional implementation of controlled interaction (tracking, assessment, and confirmation) through the use of computer technology differs considerably when one looks at the traditional application of CAI and CMI.

In CMI, the instructional load is carried by more conventional materials such as programmed texts, filmstrips, books, et cetera. The ability to mimic the tutorial question and answer type of interchange between teacher and student is limited in CMI. In CMI, controlled interaction is limited to end of lesson testing wherein a student completes a test, gets it computer graded, and then is issued a "prescription for next assignment or remediation. In some more primitive CMI systems, testing is handled manually and test data is batch processed with no direct interaction with students.

CAI, almost by definition, is tutorial with controlled interaction being provided throughout the administration of a lesson or a test, and, unlike CMI, often the working assumption of CAI is that the majority of instruction will be handled by the computer. The consequence of such an assumption is that the design of a CAI terminal supports a wide range of instructional requirements even when some

of these requirements are infrequent (e.g., dynamic graphics) or can be handled more cost-effectively (e.g., the presentation of large amounts of verbal material - page turning) by more traditional materials.

It is an unfortunate situation that CMI and CAI are too often treated in a dichotomous manner. This dichotomy between CMI and CAI is clearly shown in two recent articles. Norris (1977) in describing a nationwide network of CAI learning centers modeled on the PLATO IV system, barely recognizes other instructional functions On the other hand, Dagnon and Spuck (1977) do not even hint at the potential of using CAI in describing the Wisconsin System of Instructional Management's CMI system. The specialized function of CAI was recognized by Bitzer and Skaperdas (1969) in the early development of the PLATO IV computer system and hints at the need to use CAI in conjunction with other instructional techniques, as the following quote shows

> Some guidelines for developing the system's software and hardware are:
>
> 1) The computer should only be used when it is the best method of presentation. Less expensive methods such as programmed texts, films, slides. tape recorders, etc., should be used when appropriate.
> 2) The computer should be used as much as possible to simulate results in models constructed by the students rather than simply turning pages.
> 3) The system must be flexible and adaptable. It must be able to teach many subjects and present the lesson materials by a variety of teaching strategies...

Bunderson and Faust (1976) contend that the different uses of computers in education or instruction stem from two distinct perspectives--the computer-science perspective and the instructional design perspective. The first perspective looks at the computer as of ". . . profound intellectual interest in and of itself, not just as a possible new method of mediating old subject matter in old ways." (p. 51), and this viewpoint results in the computer being used in an adjunctive manner in the instructional system. The latter perspective looks at the computer, "Like any good medium," to be ". . . designed into a total individualized instructional environment where it can meet certain requirements uniquely well. . ." (p. 52), and this viewpoint results in the computer as a "mainline" part of the total instructional system. Mirroring the eclectic approach of the instructional design perspective are the conclusions reached by Rockart and Morton (1975) in their book, Computers and the Learning Process in Higher Education. This viewpoint states that instructional technology (courseware and hardware) will add to rather than replace existing learning mechanisms and that no single technology will suffice, but that rather a smorgasbord of learning mechanisms will be used.

It should be accepted for the time being that the presentation of instruction via the computer (usually referred to as CAI) is not the only use of computers in instruction, but rather only one of a wide range of possible uses. In the context of this paper, the

term "computer-based instruction" (CBI) is used to indicate a "mainline" usage of the computer covering a wide range of applications from simple management of instruction to sophisticated presentation of instruction, all within the context of an individualized instructional system.

System Costs and Terminal Design

The Air Force's Advanced Instructional System (Rockway and Yasutake, 1974) is an example of a large computer-based instructional system. The AIS is designed to handle a daily load of up to 2100 students for 18 hours per day. The Air Force has four technical training courses under the AIS. The first two are the Inventory Management and the Materiel Facilities Courses, both of which place a heavy emphasis on the learning of administrative functions. The third course is the Precision Measuring Equipment Course which emphasizes the learning of advanced electronic principles and troubleshooting procedures. The fourth course is the Weapons Mechanics Course, a course which involves a great deal of motor skill learning and the ability to work and function in coordinated team efforts.

The AIS as a computer-based system is primarily CMI. In this context, CAI is one of many pedagogical approaches which can be used in the AIS, but an approach which because of its present high terminal costs is limited. Cost, of course, is a major factor in the implementation of a CBI system, and any CBI system, if it is to maintain cost-effectiveness, must be sensitive to the costs of courseware (instructional materials), software, and the capital investment in hardware.

In terms of hardware, a straight CAI system is highly dependent on the cost of interactive terminals (see e.g., Albert and Bitzer, 1970). Computer costs per student for central site hardware and system software decline with an increase in students handled by the system (of course, limited by the total capacity of the system). However, as students are added to a CAI system, terminal costs increase dramatically, especially if each student is going to be on the system for most of an instructional day. The impact of terminal costs is reflected in the early cost projections made for the PLATO IV system (Bitzer and Skaperdas, 1969). These projections showed that central site hardware to support 4000 interactive terminals would be 4.5 million dollars for a cost per student contact hour (C/SCH) of 8¢. Four thousand terminals would cost 7.5 million dollars for a C/SCH of 15¢. In this projection terminal costs are almost twice central site costs. Actual experienced costs of PLATO IV hardware showed terminal costs to be almost five times as great as central computer facility costs (Alpert and Bitzer, 1970).

In most CMI systems, terminal costs are a smaller portion of total system costs or looking at it in a different manner, a set terminal investment will yield a larger user capacity in CMI than in CAI. Two courses in the AIS exemplify this situation, The Inventory Management (IM) and Materiel Facilities (MF) courses presently have a maximum capacity of 234 students for a six hour training period. This is presently handled by three computer management terminals in the AIS. The AIS has interactive terminals sirilar

to those used in the PLATO IV system. An investment in these terminals equivalent to the three management terminals would support only 36 students assuming one hour of CAI lessons. What this amounts to is that CAI in an individualized environment is 15% as effective in terms of total student numbers supported as CMI. Of course this is not a particularly new finding as other investigators have also questioned the cost-effectiveness of CAI (Okey and Majer, 1976; Anastasio, E., 1972).

Such a finding does not condemn CAI; however, as Bitzer and Skaperdas (1969) initially stated and more recently Rockert and Morton (1975) concluded, CAI computer usage can be a very powerful tool in such learning areas as simulation and problem solving. It is for learning purposes such as these, that the AIS was not designed to simply be a CMI system, though its greatest cost-effectiveness comes from this aspect, but also to support a sophisticated level of CAI. The combination of computer-managed and computer-assisted instruction into the AIS is accomplished through the mechanism of a new language called CAMIL (Computer-Assisted-Managed Instructional Language), a language which combines the capabilities of automatically collecting, manipulating and moving large amounts of data with a user-oriented command capability for presenting CAI and implementing instructional strategies.

Up to now a contrast has been drawn between CMI and CAI to

illustrate cost-efficiency problems associated with CAI and used exclusively as an instructional medium. CMI has some additional support and instructional costs associated with it. In addition to the terminal hardware cost in a CMI system, there is a cost associated with the major means for communicating data through a management terminal--the use of computer readable forms. In the AIS, these forms have been chemically treated to allow for immediate feedback of correct response to objective type questions. In the IM and MF courses under the AIS, CMI environment, the cost of forms is approximately $8500 per year. In addition to the monetary costs of forms there may be operational costs associated with the storage, ordering, and handling of these forms. There is also the occasional frustration that students experience with multitudenous darkening of small boxes to encode information.

Though the AIS is still under development and costs have not stabilized, some indication of the relation between CMI terminal costs and the support costs associated with the terminals can be had (it should be noted that there are instructional efficiency cost reductions associated with CMI which can more than offset both the cost of terminals and their immediate support costs). An anticipated stabilized cost for the AIS management terminal in its present configuration is $18,000. The relation of capital investment costs and support costs over a 5-year amortization period for the previously mentioned Inventory Management and

Material Facilities Courses is shown in Table 1. As can be seen, the cost of forms alone in a 5-year period almost equals the cost

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Place Table 1 about Here

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of the terminals and because form costs are operating costs, they will soon exceed the terminal investment. In the AIS, such cost relationships are being continually looked at. On the basis of such an evaluation, research and development work was undertaken on the development of an electronic replacement for the paper forms -- a low cost responding device which can act independent of the central computer system, like a form, and yet easily interface with the management terminals of the AIS. Such hardware development is a natural result of the attempt to match a variety of instructional requirements with hardware requirements in a CBI system. Such a matching activity will also have instructional implications.

Analyzing the instructional environment of the AIS in relation to computer support indicated three major functional areas: (1) Response Handling, (2) Information Presentation, and (3) Data Collection. These three areas broadly cover the specific functional needs of a CAI terminal as reported by Martin, Stanford, Carlson, and Mann (1975). In addition, these three categories can further be dimensionalized as static-dynamic and immediate-delayed. Response handling can be further categorized as objective and constructed, and Information

Presentation also can be further categorized as verbal and graphic. Table 2 illustrates this categorization. The AIS management terminal is typically referred to as a Type B terminal and the AIS plasma panel, interactive terminal is referred to as a Type A terminal. These code terms are placed in appropriate cells of Table 2 to illustrate how CMI and CAI differentially account for several functional terminal attributes. As a contrast, programmed text (PT) and automated A-V filmstrip (AFS) are also categorized.

Place Table 2 About Here

Microterminal Development

Somewhere between the traditional definitions of CMI and CAI lie various levels of computer-based instruction. One such level is dynamic and immediate response handling. Instructional research (Anderson, 1970; Frase, 1970; Rothkopf, 1970; and Yasutake, 1974) has shown the importance of test-like questions for maintaining attention to instruction. Also it has been shown (Anderson, Kulhavy, and Andre, 1971) that control over the interactive response situation is important to realize the benefits of the instructional technique of providing immediate knowledge of correct response. As can be seen from Table 2, a CAI terminal adequately provides for dynamic and immediate response handling, but it also provides a high and costly level of Information Presentation. There is evidence that certain instructional materials do not gain from having Information Presentation via a

computer terminal (King, 1975; Geisert, 1970), but this evidence is indicative of a need to handle a variety of instructional requirements rather than that a particular instructional attribute will never be needed. However, one should not opt for a "do everything" capability in one device unless one is ready to pay for capabilities which are not fully utilized or required.

As was mentioned earlier, research and development of a low cost responding unit was undertaken in part as a means of effecting a cost reduction by using an electronic substitute for computer readable forms. Of course, the concept of a responding device is not new. Pressey (1926) and then later Skinner (1958) and many others have proposed the use of responders or "teaching machines." Most of these devices, however, were mechanical or electro-mechanical devices which forced rigid handling of the response situation and often would require a somewhat contrived learning situation to use. The type of responding device required in the AIS was thus seen as needing to have the interactive and dynamic response handling capabilities normally associated with CRT or plasma display CAI terminals and the low-cost and ease of use which is now associated with the electronic and calculator. This device has come to be designated a "microterminal." The microterminal, its dynamic response handling capability combined with the cost-effective presentation of information provided by programmed texts or audio-visual materials, begins

to fill in the void of instructional requirements and computer usage which lie between the more traditional conceptions of CMI and CAI.

The microterminal utilizes microprocessor technology and in part derives its name from this technology. The heart of the microterminal is a Motorola M6800 microprocessor along with a 1024 bit random access memory chip and six 4096 bit, programmable read only memory chips. This microcomputer has a capacity of up to 900 test item keys permanently stored and a capacity of up to 250 test items for which a student's response is temporarily stored. In the prototype model of the microterminal, there are four testing algorithms which control the responding situation. The microterminal features a 16 key keyboard, 14 display lights allow for the indication of established directive messages, four hexidecimal display units to allow for answer feedback and a sequential form of key echoing for longer response items such as the imput of a Social Security Number. The design of this prototype microterminal was thus limited to providing for response management to effect data collection. A decision was also made to handle only objective type response situations. Without the need for extensive presentation of information and without the need to handle constructed responses, the display features of the microterminal could be limited. Informational presentation is left to regular programmed materials. All

design goals minimized cost while trying to satisfy high probability instructional requirements in the AIS. Figure 1 illustrates what the prototype microterminal looks like.

Place Figure 1 About Here

C complete technical discussion of the microterminal hardware development is provided by Kirby and Gardner (1976).

A pilot study of a prototype microterminal was performed first to verify the usability and human factors of the design, and secondly to attempt to gain a preliminary insight into potential instructional effects of the device. Results of the pilot study showed high user acceptance of the device but no test grade difference between users and non-users as determined by test scores. Significantly higher test grades for students using the microterminal to go through lesson materials was expected because of the hypotesized control over the response situation and this still may be found over more extensive use of the device. The pilot study did show that students who used the microterminal accomplished lesson materials 30% faster than the control group. The time results of the pilot study are shown in Table 3. The difference in times

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Place Table 3 About Here

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between the two groups may be due to a combination of parameters such as the time to fill out computer answer sheets, the effect of

a computer directly monitoring the student's progress, increased attending behavior due to the direct tutorial effect (at least at the level of control over the response situations) of using the responder unit (i.e., less daydreaming) or simply a Hawthorne effect.

As part of the pilot study an attitude questionnaire was administered to elicit student reactions to the device. The attitude questionnaire and student responses (%) are shown in Table 4. Three

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Place Table 4 About Here

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items in particular seem important for systems design. Item 2 reflects that students like a device versus a form for recording their responses. Item 12 shows that a computer terminal device can be built which enables one to control the response feedback situation and give clear directive type information without an elaborate computer display. In other words, we have a device which satisfies an important part of the instructional situation without having to pay for unused features such as a large display, because the information load gets carried by the programmed text. Item 13 is of particular interest. Here we have students subjectively reporting that they got more out of the responder than if they used a sheet of paper to answer embedded questions. Normally students are simply directed to record their answers on a sheet of paper with feedback being provided in back of the programmed text. The microterminal has an advantage

over this situation because the student must commit himself to an answer before it is possible for him to receive feedback.

The results of any pilot study require more extensive confirmation; however, the present results are reported because they adequately represent the viability of a particular hardware solution to an identified instructional need in a computer-based instructional system. The instructional implications of the use of a microterminal as described in this report can be significant. In the area of testing, the use of different testing strategies, test item security, and automated entry of test results for item or response analysis by a larger system become administratively feasible or simpler to implement. With more adequate control over the response-feedback element, directive control conveyed by algorithmically controlled indicator lights and changeable message cards, and properly formatted materials such as programmed texts, microfiche, or AV presentations, a low cost form of computer-assisted instruction becomes available.

A potential scenario for a computer-managed learning center using microterminal technology would be as follows: A student has just received a status report from the learning center's management terminal. He is to take a programmed text. Going to a storage cabinet, the student gets a yellow-cased microterminal and a programmed text bound in a nineteen-ring binder. Sitting down at his carrel, the student enters his student and lesson codes into the

microterminal. As he starts his instruction, the student notes that the lesson information is presented on cards color and number coded on the edges. These cards are staggered in the binding system to expose the color and number codes. Responding to embedded questions through the microterminal, the student is directed through various levels of examples, non-examples, and practice problems by display lights and alpha-numeric codes of the microterminal. Upon completion of the lesson, the student takes a lesson test using a red-cased terminal which is programmed for various testing strategies. Upon completion of the test, the student receives an immediate test score. He then carries his portable microterminal to the learning center management terminal and plugs it into the management terminal to allow automatic transfer of test data to the central computer management system. In a few seconds the student receives prescriptive information for his next instructional assignment.

Hierarchy of Terminals

What is the future of computer-based instruction? The answer to this question in part lies in the imaginative matching of computer hardware to instructional needs and design. CAI alone is too expensive. A recent article (Peters, 1976) places the cost of the commercial version of PLATO at over $5 million with terminal costs at $6000 each. It is the terminal costs in particular which make CAI expensive. CMI is a cost-effective alternate to CAI simply because more students can be handled per equivalent computer hardware; however, there are cost-effective strategies such as drill and practice (Peters, 1976; Rockart and Morton, 1975) which are

not adequately supported by simple CMI terminal hardware, but yet do not require sophisticated CAI terminal capabilities. Computer-based instruction, a system which combines the overall cost-effectiveness of CMI, but which also supports various levels of "CAI" is an effective way of providing computer support to the instructional or educational setting. To make the CBI approach feasible, imagination has to be applied to the sufficient utilization of communicative devices (i.e., terminals, AV devices, programmed materials, etc.) to satisfy particular instructional needs.

In the AIS program, the microterminal is the first step in what may potentially be a hierarchy of terminals satisfying instructional requirements from on-line CMI, through various kinds of CAI, up to very sophisticated, and highly interactive CAI presentations. In addition to the necessary requisite of good instructional design, the viability of CBI is going to depend on the usefulness and flexibility of tools offered to the instructional designer and the classroom or learning center instructor. Inappropriate computer tools are doomed to abandonment because of economic failure or because they are not a reasonable alternative to existing instructional techniques. Good, appropriate and sufficient instructional design is going to require appropriate and sufficient tools.

The conclusion then is that computer-based instruction or education needs to provide for a broad spectrum of instructional techniques. Also, because CBI is significantly dependent on terminal costs, the

solution to high costs is to provide a mix of terminals in the context of the CBI system, each designed to specific levels of instructional needs and requirements. The hand calculator phenomenon exemplifies this conclusion. The availability of low cost four function calculators established the market even though high capability and high cost calculators are also available. In computer-based instruction, this same situation must be created.

References

1. Alpert, D. and Bitzer, D. L. Advances in Computer-based education Science, 20 Mar 1970, 167, 1582-1590.

2. Anastasio, E. Computer-based Education: Obstacles to its use and plans for future action. Viewpoints, 1974, 50, 11-37.

3. Anderson, R.C. Control of student mediating processes during verbal learning and instruction. Review of Educational Research, 1970, 40, No. 3, 349-370.

4. Anderson, R.C.; Kulhavy, R.W.; and Andre, T. Feedback procedures in programmed instruction. Journal of Educational Psychology 1971, 62, 148-155.

5. Bitzer, D. and Skaperdas, D. The Design of An Economically Viable Large-Scale Computer Based Education System, CERL Report X-5, Computer-based Education Laboratory, Univ. of Ill.

6. Bunderson, C. Victor and Faust, Gerald W. Programmed and Computer-Assisted Instruction. In The Psychology of Teaching Methods, Gage, N. L. (Ed.), Chicago, National Society for the Study of Education. 1976, pp 44-90.

7. Dagnon, Carol and Spuck, Dennis W. A role for Computers in Individualizing Education - and It's Not Teaching. Phi Delta Kappan, 1977, 58(6), 460-462.

8. Frase, Lawrence T. Boundry conditions for mathemagenic behaviors. Review of Educational Research, 1970, 40, No. 3, 337-348.

9. Geisert, Paul. A Comparison of the Effects of Information Mapped Learning Materials and Traditional Materials on the Learning of Concepts Via the Printed Page and Computer Cathode Ray Tube. Tech Memo No. 24, CAI Center, Florida State University, Tallahassee, Florida, Oct 1970.

10. King, William A. A Comparison of Three Combinations of Text and Graphics For Concept Learning. NPRDC TR 76-16, Navy Personnel Research and Development Center, San Diego, Calif., 1975.

11. Kirby, P.J. and Gardner, E.M. Microcomputer Controlled, Interactive Testing Terminal Development. AFHRL-TR-76-66, Air Force Human Resources Laboratory, Technical Training Division, Lowry AFB., Colorado, 1974.

12. Martin, T.H., Stanford, M.D., Carlson, F.R., and Mann, W.C. A Policy Assessment of Priorities and Functional Needs for the Military Computer-Assisted Instruction Terminal. ISI/RR-75-44, Information Sciences Institute, University of Southern California, Marina del Rey, California, Dec. 1975.

13. Norris, William C. Via Technology to a New Era in Education. Phi Delta Kappan, 58 (Feb, 1977), 451-453.

14. Okey, J.R. and Majer K. Individual and Small-Group Learning with Computer-Assisted Instruction. AV Communications Review Spring 1976, 24, 79-86.

15. Peters, H. J. The electronic Aristotle. Computer Decisions, July 1976, 8, 42-46.

16. Pressey, S. L. A Simple Apparatus which Gives Tests and Scores - and Teaches. School and Society, 1926, 23, 373-376.

17. Rockart, John F. and Morton, M.S. Scott. Computers and the Learning Process in Higher Education. New York, McGraw-Hill, 1975.

18. Rockway, M. and Yasutake, J. The Evolution of the Air Force Advanced Instructional System. J. Educ. Tech Systems, Winter, 1974, 2, 217-239.

19. Rothkopf, E. Z. The concept of mathemagenic activities. Review of Educational Research, 1970, 40, No. 3, 325-336.

20. Skinner, B. F. Teaching Machines. Science, 1958, 128, 969-977.

21. Yasutake, J. Y. The Effects of Pacing and Mode of Adjunct Questions on Short and Long Term Retention of Written Materials. AFHRL-TR-74-72, Air Force Human Resources Laboratory, Technical Training Division, Lowry AFB, Colorado, 1974.

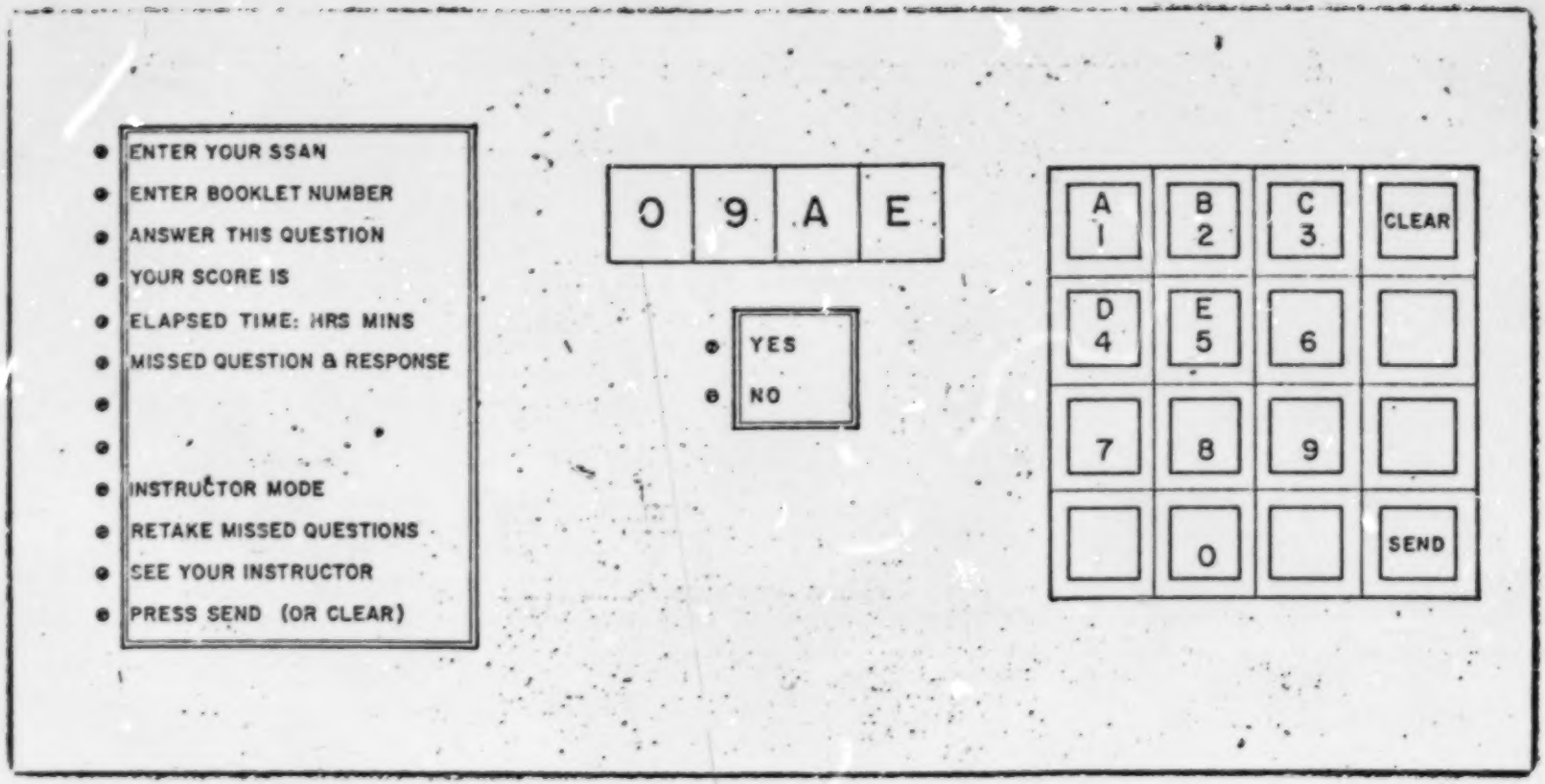

Figure 1. Microterminal Faceplate
(Full Size)

Capital Cost	5 Yr Amortization (4000 Students/Yr)
(3 Terminals) $54K	$2.70/Student
(Forms) $8.5K/Yr	$2.13/Student

Table 1 - AIS Management Terminal and Forms Cost per Student

	Response Handling		Information Presentation		Data Collection
	Objective	Constructed	Verbal	Graphic	
Dynamic	A	A	A	A	A
Static	B PT AFS	PT	PT AFS	PT AFS	B
Immediate	AFS	A	A	A	A
Delayed	PT B				B

Legend
A = AIS Interactive Terminal
B = AIS Management Terminal
PT = Programmed Text
AFS = Audio, Filmstrip

Table 2 - Functional Attributes of CBI Terminal Hardware and Instructional Materials

LESSON TIME

Control	Microterminal
N=12	N=12
$\bar{X}$=168.08 min	$\bar{X}$=117.75 min
s=80.5	s=50.5

t = -1.85 sig at .05 (one tailed)

Table 3 - Lesson Completion Times

1.	WHAT WAS YOUR OPINION OF THE RESPONDER?	GOOD (86%) BAD (7%) INDIFFERENT (7%)	
2.	WHICH DO YOU LIKE BETTER?	RESPONDER (89%) FORM (11%)	
		YES	NO
3.	DID YOU FEEL ANY TYPE OF PRESSURE? IF YES, WHY?	18%	82%
4.	DID YOU FEEL NERVOUS IN USING THE RESPONDER? IF YES, WHY?	20%	80%
5.	DID YOU FEEL RUSHED? IF YES, WHY?	7%	93%
6.	DID YOU GET FRUSTRATED? IF YES, WHY?	18%	82%
7.	WAS SOMEONE PRESENT WATCHING YOU USE THE RESPONDER?	47%	53%
8.	DID THIS MAKE YOU NERVOUS IN ANY WAY? IF YES, IN WHAT WAY?	7%	93%
9.	DO YOU FEEL UNCOMFORTABLE ABOUT THE COMPUTER GRADING YOUR TESTS?	5%	95%
10.	IS THE DEVICE HARD TO USE?	0%	100%
11.	COULD YOU UNDERSTAND THE INSTRUCTIONS IN YOUR LESSON BOOKLET? IF NOT, HOW WOULD YOU IMPROVE IT?	93%	7%
12.	ARE THE RESPONDER' RED LIGHTS AND THEIR CORRESPONDING INSTRUCTIONS EASY TO USE?	100%	0%
13.	DID YOU GET MORE OUT OF THE PROGRAMMED TEXT QUESTIONS USING THE RESPONDER RATHER THAN THE USUAL WAY OF ANSWERING ON A SHEET OF PAPER OR IN YOUR HEAD?	88%	12%
14.	DID YOU LIKE THE ABILITY TO CONTINUE RESPONDING UNTIL YOU RECEIVED THE RIGHT RESPONSE FOR EACH QUESTION?	98%	2%

Table 4 - Questionnaire Results of
Student's Acceptance of the Microterminal